English Translation of Japanese Laid-Open Paten Application No. 11-46161

[Title of the Invention] Wireless multicast data transfer method

[Abstract]

[Problem] To present a multicast data transfer method capable of preventing decline of reliability even in communication line of poor quality, shortening the time required for response even if the number of receiving stations is increased, and preventing decline of data transfer efficiency.

[Solving Means] Receiving stations are divided into groups capable of transmitting and receiving mutually between stations, a representative station is selected from each group, a transmitting station polls each group after transmitting a series of multicast data and returns an ACK to the representative station only, other receiving stations in the group monitor the response returned by the representative station, and returns a NAK to the transmitting station only when necessary to request retransmission by judging from the result of reception at the own station, and the transmitting station retransmits only the requested frame when the NAK is returned, and restarts polling after retransmission, or polls next group when only the ACK is returned.

[Claims]

[Claim 1] A wireless multicast data transfer method for transferring multi-address data from a transmitting station to plural receiving stations by wireless multicast communication,

wherein said transmitting station divides the receiving stations into groups, selects one arbitrary receiving station from each group as a representative station, and requests response by polling one of the groups after transmitting final frame of multi-address data to the receiving station groups,

the representative station of the group being polled returns an affirmative acknowledge to the transmitting station when the multi-address data is received correctly, or returns a negative acknowledge thereto, together with a wrong frame number, when the multi-address data is not received correctly,

other stations than the representative station in the polled group monitor the result returned by the representative station, and returns to the transmitting station, together with the frame number requesting retransmission to the negative acknowledge within a specific time, when the response returned from the representative station is an affirmative response or when the response of the representative station cannot be monitored and cannot be received correctly in the frame of the multi-address data, and

the transmitting station, when retransmission is requested by negative acknowledge, suspends polling, retransmits a frame having a requested number immediately by multicast, polls anew the representative station of the group suspended earlier after retransmission, and polls next group

when negative acknowledge is not returned within the specified time after receiving the affirmative acknowledge from the representative station.

[Claim 2] A wireless multicast data transfer method for wireless multicast communication composed of a transmitting station for transferring multi-address data by wireless multicast communication and plural receiving stations for receiving the multi-address data, wherein said transmitting station fragments the multi-address data as required, creates a frame having addresses and transmission sequence numbers of destination receiving station group, and transfers data to the plural receiving stations by one frame transmission, said receiving stations return an affirmative acknowledge when receiving the multi-address data correctly, or return the frame number detecting an error to the transmitting station by negative acknowledge when detecting an error of the frame, and the transmitting station retransmits the multi-address data of the number specified in the negative acknowledge when receiving the negative acknowledge, more specifically,

(1) the transmitting station divides receiving stations capable of transmitting and receiving directly into groups,

(2) the transmitting station selects one arbitrary receiving station from each group as a representative station,

(3) the transmitting station transmits the multi-address frame adding address and sequence to the multi-address data, to the receiving station groups, and after transmitting the final frame,

(4) the transmitting station requests response by polling one of the groups,

(5) the representative station of the polled group returns an affirmative acknowledge when the multi-address data is received correctly, or returns a negative acknowledge together with wrong frame number as response when the multi-address data is not received correctly,

(6) other stations than the representative station in the polled group monitor the result returned from the representative station, and return to the transmitting station by attaching a frame number requesting retransmission to the negative acknowledge within a specified time T1 when the response returned from the representative station is an affirmative acknowledge, or when the response from the representative station is not monitored and is not received correctly in the frame of the multi-address data,

(7) the transmitting station suspends polling when retransmission is requested by negative acknowledge, retransmits the frame having the requested number immediately by multicast, polls anew the representative station suspended of polling after retransmission, and polls next group when negative acknowledge is not returned within a specific time T1 after reception of affirmative acknowledge from the representative station, and

(8) the transmitting station repeats steps (4) to (7), terminates polling of all groups, and completes multicast data transfer when receiving an affirmative acknowledge from the

representative station of the final group.

[Claim 3] A wireless multicast data transfer method for transferring multi-address data from a transmitting station to plural receiving stations by wireless multicast communication,

wherein said transmitting station divides the receiving stations into groups, selects one receiving station most likely to cause transmission error from each group as a representative station, and requests response by polling one of the groups after transmitting final frame of multi-address data to the receiving station groups,

the representative station of the group being polled returns an affirmative acknowledge to the transmitting station when the multi-address data is received correctly, or returns a negative acknowledge thereto, together with a wrong frame number, when the multi-address data is not received correctly,

other stations than the representative station in the polled group monitor the result returned by the representative station, and returns to the transmitting station, together with the frame number requesting retransmission to the negative acknowledge within a specific time, when the response returned from the representative station is an affirmative response or when the response of the representative station cannot be monitored and cannot be received correctly in the frame of the multi-address data, and

the transmitting station, when retransmission is requested by negative acknowledge, suspends polling, retransmits a frame having a requested number immediately by

multicast, polls anew the representative station of the group suspended earlier after retransmission, and polls next group when negative acknowledge is not returned within the specified time after receiving the affirmative acknowledge from the representative station.

[Claim 4] A wireless multicast data transfer method for wireless multicast communication composed of a transmitting station for transferring multi-address data by wireless multicast communication and plural receiving stations for receiving the multi-address data, wherein said transmitting station fragments the multi-address data as required, creates a frame having addresses and transmission sequence numbers of destination receiving station group, and transfers data to the plural receiving stations by one frame transmission, said receiving stations return an affirmative acknowledge when receiving the multi-address data correctly, or return the frame number detecting an error to the transmitting station by negative acknowledge when detecting an error of the frame, and the transmitting station retransmits the multi-address data of the number specified in the negative acknowledge when receiving the negative acknowledge, more specifically,

(1) the transmitting station divides receiving stations capable of transmitting and receiving directly into groups,

(2) the transmitting station selects one receiving station most likely to cause transmission error from each group as a representative station,

(3) the transmitting station transmits the multi-address

frame adding address and sequence to the multi-address data, to the receiving station groups, and after transmitting the final frame,

(4) the transmitting station requests response by polling one of the groups,

(5) the representative station of the polled group returns a affirmative acknowledge when the multi-address data is received correctly, or returns a negative acknowledge together with wrong frame number as response when the multi-address data is not received correctly,

(6) other stations than the representative station in the polled group monitor the result returned from the representative station, and return to the transmitting station by attaching a frame number requesting retransmission to the negative acknowledge within a specified time T when the response returned from the representative station is an affirmative acknowledge, or when the response from the representative station is not monitored and is not received correctly in the frame of the multi-address data,

(7) the transmitting station suspends polling when retransmission is requested by negative acknowledge, retransmits the frame having the requested number immediately by multicast, polls anew the representative station suspended of polling after retransmission, and polls next group when negative acknowledge is not returned within a specific time T1 after reception of affirmative acknowledge from the representative station, and

(8) the transmitting station repeats steps (4) to (7), terminates polling of all groups, and completes multicast data transfer when receiving an affirmative acknowledge from the representative station of the final group.

[Detailed Description of the Invention]

[0001]

[Technical Field of the Invention]

The present invention relates to a data transfer method in wireless multicast communication. More particularly, when transferring multi-address data by wireless multicast communication, the invention relates to wireless multicast communication in which a transmitting station fragments multi-address data as required, forms a frame by relating the address and transmission sequence number to each other, and transfers the data to plural receiving stations by one frame transmission, receiving stations receive multi-address data and return a response frame to the transmitting station, and the transmitting station retransmits the frame as required.

[0002]

[Prior Art]

In conventional multicast communications, as means for transferring same data to specified plural receiving stations, Internet Engineering Task Force and others have been studied. In Internet (IP) multicast using IP protocol, service of best effort is assumed, and retransmission of wrong packet in data transfer is not taken into consideration ("Hot Extension for IP Multicast," IETF RFC1112, 1986).

[0003]

In multicast communication system considering retransmission of wrong data, when a receiving station detects an error in the received packet or data frame, retransmission is requested by sending back negative acknowledgement (NAK) specifying the wrong frame number to the transmitting station as the response. The transmitting station retransmits when retransmission is requested by NAK.

[0004]

Fig. 1 is a diagram showing an example of conventional multicast data transfer, in which the mode of multicast data transfer from a transmitting station 101 to receiving stations 201 to 205 is shown together with the lapse of time. In the diagram, a blank cell is a data frame, and the given number is the sequence number assigned to the frame. A downward arrow indicates the lapse of time, and an oblique arrow shows the mode of transmission of frame. In this diagram, multicast data is divided into four frames, and transmitted to the receiving stations.

[0005]

The transmitting station 101 transmits a series of multicast data frames, and waits for response from receiving stations. In the diagram, the transmitting station 101 transmits first to fourth frames. A receiving station, if detecting an error in the received multicast data frame, requests retransmission by returning the wrong frame number in NAK frame to the transmitting station. In this example, the

receiving station 201 detects an error in the second frame, and the receiving station 205 detects an error in the third frame. The receiving station 201 returns a NAK 321 requesting retransmission of the second frame, and the receiving station 205 returns a NAK 322 requesting retransmission of the third frame, to the transmitting station 101. The transmitting station 101 receives the NAK 321 and NAK 322, and retransmits the second and third data frames requested by the NAK 321 and NAK 322. In the diagram, retransmission of the second and third data frames is indicated as retransmission frames 331 and 332, respectively.

[0006]

After retransmission, the transmitting station 101 regards the data transfer is successful if further request for retransmission of frame is not received. At this moment, if there is subsequent multicast data, the transmitting station 101 can transfer next multicast data. After a series of multicast data transfer, the transmitting station 101 transfers as required in the same procedure. In this case, the transmitting station 101 transmits fifth to eighth multicast data frames, and after transmission of series of multicast data, the receiving station 203 detects an error in the seventh frame. The receiving station 203 returns a NAK 323 requesting retransmission of the seventh frame, but the NAK 323 fails to reach the transmitting station 101 due to error on the transmission path. In such a case, the transmitting station 101 cannot recognize the necessity of retransmission.

Therefore, the transmitting station 101 regards the transfer of multicast data by the fifth to eighth frames is successful.

[0007]

The transmitting station 101 terminates transmission if there is no subsequent data, and the multicast data transfer to the receiving station 203 results in a failure in this case.

[0008]

Fig. 2 shows other example of conventional multicast data transfer, in which the mode of multicast data transfer from a transmitting station 101 to receiving stations 201 to 205 is shown together with the lapse of time. In the diagram, a blank cell is a data frame, and the given number is the sequence number assigned to the frame. A solid cell rectangle shows a NAK, and a shaded rectangle shows an acknowledgement (ACK). A downward arrow indicates the lapse of time, and an oblique arrow shows the mode of transmission of frame. In this diagram, multicast data is divided into four frames, and transmitted to the receiving stations.

[0009]

The transmitting station 101 transmits a series of multicast data frames, and waits for response from receiving stations. In the diagram, the transmitting station 101 transmits first to fourth frames. Receiving stations return an ACK to the transmitting station 101 if all transmitted multicast data frames are received without error. In the diagram, the receiving station 202 and receiving station 203 return ACK 311 and ACK 312. If a receiving station detects an

error in the received multicast data frame, it requests retransmission by returning the wrong frame number in NAK frame to the transmitting station. In this example, the receiving station 201 detects an error in the second frame, and the receiving station 205 detects an error in the third frame. At this time receiving station 201 returns a NAK 321, and the receiving station 205 returns a NAK 322, thereby requesting retransmission of the second and third frames respectively.

[0010]

When receiving a NAK, the transmitting station 101 retransmits the frame of the number requested by this NAK. In the diagram, the transmitting station 101 retransmits the second and third data frames requested by the NAK 321 and NAK 322. The receiving station requesting retransmission returns an ACK to the transmitting station 101 when the requested frame is received correctly. In the diagram, the receiving station 201 and receiving station 205 return ACK 313 and ACK 314 respectively, and inform the transmitting station 1001 of successful reception. When the ACK is returned from all receiving stations, the transmitting station regards the completion of transmission. In this case, when receiving ACK 314, the transmitting station 101 regards completion of transmission of multicast data 301.

[0011]

After completion of transmission of multicast data, the transmitting station 101 can transfer the subsequent multicast data. In the diagram, after completion of transfer of multicast

data 301, multicast data 302 is transferred. The multicast data 302 is transferred in fifth to eighth frames, and the receiving station 203 detects an error in the seventh frame. In this case, retransmission is requested in the same procedure.

[0012]

In the diagram, the ACK 317 from the receiving station 204 fails to reach the transmitting station 101 due to error. In such a case, the transmitting station 101 cannot recognize the reception status in the receiving station 205. Therefore, the transmitting station 101, in order to get information of the reception status in the receiving station 205., polls the receiving station 205 on the occasion of expiration of the timer which is started at the end of transmission of multicast data 302. The receiving station 205, in response to a polling signal 341 from the transmitting station 101, notices the state of the own station to the transmitting station 101. After receiving an ACK 319, the transmitting station 101 regards the completion of retransmission of multicast data 302.

[0013]

[Problems that the Invention Is to Solve]

Hitherto, multicast data were transferred in the methods mentioned above. In the conventional multicast data transfer method shown in Fig. 1, the transmitting station retransmits as being triggered by NAK. In this case, if the NAK fails to reach the transmitting station correctly due to transmission error, or NAKs transmitted from plural stations collide on the transmission path, the transmitting station cannot recognize

the necessity of retransmission, and necessary retransmission is not made, and therefore the reliability of multicast data transfer is lowered.

[0014]

Or, if a fragmented final frame has an error, since there is no subsequent frame, missing of sequence number cannot be detected, and retransmission is not requested, and necessary retransmission is not made, and in particular in the wireless transmission path often causing errors, the reliability of multicast data transfer is lost.

[0015]

To lower the collision probability of NAK frames when the receiving stations return NAKs, it has been attempted to use back-off algorithm or link connection individually to return responses, but if many receiving stations are involved, it takes an enormous time to acknowledge transmission, and the transfer efficiency of multicast data declines.

[0016]

In the conventional multicast data transfer method shown in Fig. 2, the reliability is assured by using both ACK and NAK to acknowledge transmission, but the transmitting station must receive responses from all receiving stations. When returning ACK or NAK responses, the receiving stations use back-off algorithm to lower the collision probability of response frames or link connection individually to return responses, but in this case, too, if many receiving stations are involved, it takes an enormous time to acknowledge transmission.

[0017]

Also in the conventional multicast data transfer method shown in Fig. 2, if a fragmented final frame has an error, the receiving station cannot detect error in the frame. Therefore, the receiving station cannot return response, and in this case the transmitting station is designed to poll on the occasion of expiration of timer as recovery measure. As a result, it takes a long time to acknowledge transmission, and the data transfer efficiency is lowered.

[0018]

Therefore, the invention is intended to solve these problems in the conventional multicast data transfer, and it is an object thereof to present a multicast data transfer method capable of preventing decline of reliability even in communication path of poor quality, shortening the required response time if the number of receiving stations is increased, and preventing decline of data transfer efficiency.

[0019]

[Means for Solving the Problems]

The invention presents a wireless multicast data transfer method for wireless multicast communication composed of a transmitting station for transferring multi-address data by wireless multicast communication and plural receiving stations for receiving the multi-address data, in which the transmitting station fragments the multi-address data as required, creates a frame having addresses and transmission sequence numbers of destination receiving station group, and transfers data to the

plural receiving stations by one frame transmission, the receiving stations return an ACK when receiving the multi-address data correctly, or return the frame number detecting an error to the transmitting station by NAK when detecting an error of the frame, and the transmitting station retransmits the multi-address data of the number specified in the NAK when receiving the NAK, more specifically, (1) the transmitting station divides receiving stations capable of transmitting and receiving directly into groups, (2) the transmitting station selects one arbitrary receiving station from each group as a representative station, (3) the transmitting station transmits the multi-address frame adding address and sequence to the multi-address data, to the receiving station groups, and after transmitting the final frame, (4) the transmitting station requests response by polling one of the groups, (5) the representative station of the polled group returns an ACK when the multi-address data is received correctly, or returns a NAK together with wrong frame number as response when the multi-address data is not received correctly, (6) other stations than the representative station in the polled group monitor the result returned from the representative station, and return to the transmitting station by attaching a frame number requesting retransmission to the NAK within a specified time T1 when the response returned from the representative station is an ACK, or when the response from the representative station is not monitored and is not received correctly in the frame of the multi-address data, (7) the transmitting station

suspends polling when retransmission is requested by NAK, retransmits the frame having the requested number immediately by multicast, polls anew the representative station suspended of polling after retransmission, and polls next group when NAK is not returned within a specific time T1 after reception of ACK from the representative station, and (8) the transmitting station repeats steps (4) to (7), terminates polling of all groups, and completes multicast data transfer when receiving an ACK from the representative station of the final group. [0020]

The invention further presents a wireless multicast data transfer method for wireless multicast communication composed of a transmitting station for transferring multi-address data by wireless multicast communication and plural receiving stations for receiving the multi-address data, in which the transmitting station fragments the multi-address data as required, creates a frame having addresses and transmission sequence numbers of destination receiving station group, and transfers data to the plural receiving stations by one frame transmission, the receiving stations return an ACK when receiving the multi-address data correctly, or return the frame number detecting an error to the transmitting station by NAK when detecting an error of the frame, and the transmitting station retransmits the multi-address data of the number specified in the NAK when receiving the NAK, more specifically, (1) the transmitting station divides receiving stations capable of transmitting and receiving directly into groups, (2) the

transmitting station selects one receiving station most likely to cause transmission error from each group as a representative station, (3) the transmitting station transmits the multi-address frame adding address and sequence to the multi-address data, to the receiving station groups, and after transmitting the final frame, (4) the transmitting station requests response by polling one of the groups, (5) the representative station of the polled group returns an ACK when the multi-address data is received correctly, or returns a NAK together with wrong frame number as response when the multi-address data is not received correctly, (6) other stations than the representative station in the polled group monitor the result returned from the representative station, and return to the transmitting station by attaching a frame number requesting retransmission to the NAK within a specified time T1 when the response returned from the representative station is an ACK, or when the response from the representative station is not monitored and is not received correctly in the frame of the multi-address data, (7) the transmitting station suspends polling when retransmission is requested by NAK, retransmits the frame having the requested number immediately by multicast, polls anew the representative station suspended of polling after retransmission, and polls next group when NAK is not returned within a specific time T1 after reception of ACK from the representative station, and (8) the transmitting station repeats steps (4) to (7), terminates polling of all groups, and completes multicast data transfer when receiving an ACK from the representative station of the

final group.

[0021]

[Embodiments of the Invention]

Referring now to the drawings, preferred embodiments of the invention are described in detail below.

[0022]

Fig. 3 shows a first embodiment of the invention, in which the mode of multicast data transfer from a transmitting station 101 to receiving stations 201 to 205 is shown together with the lapse of time. In the diagram, a blank cell is a data frame, and the given number is the sequence number assigned to the frame. A downward arrow indicates the lapse of time, and an oblique arrow shows the mode of transmission of frame. In this diagram, multicast data 301 and 302 are individually divided into four frames, and transmitted to the receiving stations.

[0023]

The receiving stations are divided into groups, and the receiving station 201 and receiving station 202 belong to group 211, and the receiving station 203 and receiving station 204 belong to group 212. This mode is more specifically shown in Fig. 6 for explaining grouping of receiving stations in this embodiment.

[0024]

The transmitting station 101 selects a representative station from each group at random prior to transmission of multicast data. As shown in Fig. 6, suppose the receiving station 201 is representative in group 211, and the receiving

station 203 in group 212. Further, a receiving station 205 is supposed to be independent. This receiving station 205 alone forms one group 213.

[0025]

Fig. 4 is a flowchart of operation of the transmitting station 101 in the embodiment, and Fig. 5 is a flowchart of operation of the receiving stations 201 to 205 in the embodiment. Referring to Fig. 3 to Fig. 5, the operation of wireless multicast data transfer in the embodiment is explained.

[0026]

The transmitting station 101 transmits a series of multicast data (S1 in Fig. 4). In Fig. 3, first to fourth frames are transmitted. The transmitting station 101, after finishing transmission of multicast data, polls the representative station of each group (S2 in Fig. 4). First, the receiving station 201 which is the representative station of group 211 is polled. In Fig. 3, reference numeral 341 is this polling signal.

[0027]

On the other hand, when receiving multicast data (S10 in Fig. 5), the receiving station judges if itself is the representative station or not (S11 in Fig. 5). In the case of the representative station, the polling signal is received (S12 in Fig. 5), and a response is transmitted (S13 in Fig. 5). In Fig. 3, since the receiving station 201 has received all frames without error, an ACK 311 is returned (S14 in Fig. 5).

[0028]

The receiving station 202 which is a member of group 211, when receiving multicast data (S10 in Fig. 5), judges if itself is the representative station or not (S11 in Fig. 5). If the own station is not the representative station, it is judged if there is error in the received data (S15 in Fig. 5). If an error is found, the polling signal to the representative station 201 and its response are monitored (S16 in Fig. 5), and if the response returned by the representative station 201 is not the one to inform the transmitting station 101 of the status of the own station, that is, error of the second frame (S17 in Fig. 5), NAK 321 is returned successively to ACK 311 (S18 in Fig. 5).

[0029]

The transmitting station 101, when receiving NAK 321 (S3 in Fig. 4), promptly retransmits the requested frame 331 (S5 in Fig. 4). Retransmission is made in multicast, and all receiving stations in the coverage area 111 of the transmitting station can receive a retransmission frame 331. However, when the second frame has been already received correctly, the second frame received at the time of retransmission is discarded.

[0030]

After retransmission, the transmitting station 101 polls again the representative station 201 of group 211 (S2 in Fig. 4). Polling 342 in the diagram corresponds to this. The representative station 201 of group 211 returns ACK 312 (S12 to A14 in Fig. 5). The receiving station 202, when correctly receiving the retransmitted frame 331, does nothing because all

data has been already received.

[0031]

The transmitting station 101, after receiving ACK 312 from the representative station 201 of group 211, polls the representative station of next group unless NAK is received within a specified time interval T1 (S4 in Fig. 4). In this case, therefore, the transmitting station 101 polls 343 the receiving station 203 which is the representative station of group 212.

[0032]

In this procedure, the transmitting station 101 polls up to group 213 which is the final group, and when receiving ACK 314 from the final group, it is regarded that the transmission of multicast data 301 is complete (S6 in Fig. 4).

[0033]

Next, the transmitting station 101 transmits the next multicast data 302 similarly.

[0034]

Fig. 7 shows a second embodiment of the invention, in which the mode of multicast data transfer from a transmitting station 101 to receiving stations 201 to 205 is shown together with the lapse of time. In the diagram, a blank cell is a data frame, and the given number is the sequence number assigned to the frame. A downward arrow indicates the lapse of time, and an oblique arrow shows the mode of transmission of frame. In this diagram, multicast data 301, 302 are individually divided into four frames, and transmitted to the receiving stations.

[0035]

The receiving stations are divided into groups, and the receiving station 201 and receiving station 202 belong to group 211, and the receiving station 203 and receiving station 204 belong to group 212. This mode is more specifically shown in Fig. 8 for explaining grouping of receiving stations in this embodiment.

[0036]

The transmitting station 101 selects the station most likely to cause transmission error from each group as a representative station, on the basis of the past communication history or network topology management information, prior to transmission of multicast data of receiving stations, by making use of communication history information with each receiving station. In the diagram, suppose the receiving station 202 is representative in group 211, and the receiving station 203 in group 212. Further, a receiving station 205 is supposed to be independent, and this receiving station 205 alone forms one group 213.

[0037]

The transmitting station 101 transmits a series of multicast data 301. In Fig. 7, first to fourth frames are transmitted. The transmitting station 101, after finishing transmission of multicast data, polls the representative station of each group. First, the receiving station 202 which is the representative station of group 211 is polled.

[0038]

The polled receiving station 202, detecting an error in the second frame, returns NAK 321. The receiving station 201 which is a member of group 211 monitors the polling and its response. At this time, in the receiving station 201, all frames of the preceding multicast data 301 are correctly received, and the own station is not the representative station of the group, and no response is returned.

[0039]

The transmitting station 101, when receiving NAK, promptly retransmits the requested frame. Retransmission is made in multicast, and all receiving stations in the coverage area of the transmitting station can receive a retransmission frame 331. However, in the station in which the second frame has been already received correctly, the second frame received at the time of retransmission is discarded.

[0040]

After retransmission, the transmitting station 101 polls again the representative station of group 211 (polling 2 in the diagram corresponds to this). The receiving station 202 returns ACK 311 this time because the retransmitted frame 331 is received correctly.

[0041]

The transmitting station, after receiving ACK 311 from the representative station 201 of group 101, polls the representative station of next group unless NAK is received within a specified time interval T1 from other receiving station. Therefore, in Fig. 7, the transmitting station 101 polls the

receiving station 203 which is the representative station of group 212.

[0042]

In this procedure, the transmitting station polls up to group 213 which is the final group, and when receiving ACK from the final group, it is regarded that the transmission of multicast data 301 is complete.

[0043]

When receiving the ACK from the final group, the transmitting station can start transmission of next multicast data. In the diagram, the multicast data 302 is transferred in the fifth to eighth frames. After transmission of multicast data 302, the transmitting station 101 acknowledges transmission by the method explained above. Herein, suppose the seventh frame is wrong in the receiving station 203 and receiving station 205.

[0044]

The transmitting station 101 polls each group, and when polling in group 212, the receiving station 203 which is the representative station of group 212 requests retransmission of the seventh frame. The transmitting station 101 receives NAK 322 as retransmission request from the receiving station 203, and immediately start retransmission of the seventh frame. In the diagram, this retransmission is expressed as 322. At this time, the retransmission frame 332 can be received in all receiving stations in the coverage area of the transmitting station 101, and the receiving station 205 also receives the

seventh frame.

[0045]

After transmitting 332, the transmitting station 101 polls the group 212 again. After receiving ACK 315, the receiving station 205 which is the representative station of group 213 is polled. In the receiving station 205, since the wrong frame in the initial transmission has been already recovered by retransmission frame 332, ACK 316 is returned.

[0046]

After receiving ACK 316, the transmitting station 101 regards the transmission of multicast data 302 is complete.

[0047]

The foregoing embodiments are exemplary examples of the invention and are not limitative, and the invention may be effected in various changes and modifications. Therefore, the scope of the invention should be defined within the range of the claims and its equal range.

[0048]

[Effects of the Invention]

According to the invention, as described herein, when transferring multicast data, the transmitting station divides receiving stations into groups capable of transmitting and receiving mutually, selects one representative station from each group, transmits a series of multicast data, and polls each group, only the representative station returns ACK, while other receiving stations in each group monitor the response returned by the representative station, NAK is returned to the

transmitting station only when necessary to request retransmission as judging from the reception result of the own station, the transmitting station retransmits only the requested frame when NAK is returned, and restarts polling after retransmission, and polls next group when only ACK is returned, and therefore the transmitting station completes multicast data transfer only when ACK is returned from the final group, thereby realizing a highly efficient multicast data transfer by shortening the time for acknowledging transmission while assuring a high reliability.

[0049]

In the invention, if the frame requested to be retransmitted by one receiving station in a certain group is also requested to be retransmitted by other receiving station in the same group, the moment that the frame is first retransmitted, it can be received in all stations requesting retransmission of the same frame, and therefore as for this frame, probability of retransmission in the same group is decreased, so that an efficient retransmission is realized.

[0050]

Further according to the invention, when transferring multicast data, the transmitting station preliminarily manages the communication quality of the communication path to each receiving station and network topology, divides receiving stations into groups capable of transmitting and receiving mutually, selects the one most likely to cause transmission error from each group as a representative station, transmits

a series of multicast data, and polls each group, only the representative station returns ACK, while other receiving stations in each group monitor the response returned by the representative station, NAK is returned to the transmitting station only when necessary to request retransmission as judging from the reception result of the own station, the transmitting station retransmits only the requested frame when NAK is returned, and restarts polling after retransmission, and polls next group when only ACK is returned, and therefore the transmitting station completes multicast data transfer only when ACK is returned from the final group, thereby realizing a highly efficient multicast data transfer by shortening the time for acknowledging transmission while assuring a high reliability.

[0051]

In the invention, in addition of the effects of the above aspect of the invention, by polling the station most likely to cause transmission error when acknowledging transmission, the number of frames returned as response is curtailed, and the required time for retransmission is shortened, so that a highly efficient multicast data transfer is realized.

[Brief Description of the Drawings]

Fig. 1 is a diagram showing an example of conventional multicast data transfer.

Fig. 2 is a diagram showing other example of conventional multicast data transfer.

Fig. 3 is a diagram explaining a first embodiment of the

invention.

Fig. 4 is a flowchart of operation of multicast data transmitting station according to the invention.

Fig. 5 is a flowchart of operation of multicast data receiving station according to the invention.

Fig. 6 is a diagram explaining an example of grouping of receiving stations according to the invention.

Fig. 7 is a diagram explaining a second embodiment of the invention.

Fig. 8 is a diagram explaining other example of grouping of receiving stations according to the invention.

[Reference Numerals]

101 Transmitting station

111 Coverage area of transmitting station

201-205 Receiving station

211-213 Receiving station group

221, 222 Multicasts non-receiving terminal

301, 302 Multicast data

311-319 ACK frame

321-323 NAK frame

331-333 Retransmission frame

341-347 Polling signal

T1 NAK response wait time

Fig. 1

101 Transmitting station

201 Receiving station

301 Multicast data

Retransmission

331 Retransmission frame

Direction of lapse of time

Transmission failure

Fig. 2

Time expires

Polling 341

Fig. 3

211 Group

Monitoring

Discarding

Fig. 4

S1 Transmission of multicast data

S2 Polling

S3 Acknowledged?

S4 Any subsequent NAK?

S5 Retransmission

S6 End of polling of all groups

Fig. 5

S10 Reception of multicast data

S11 Representative station?

S12 Reception of polling signal

S13 Transmission of acknowledgement

S14 Acknowledged?

S15 Error detected?

S16 Monitoring of response of representative station

S17 Matched with reception result?

S18 Transmission of NAK

Fig. 6

221 Multicast non-receiving terminal

205 Receiving station (representative station of group 213)

111 Coverage area of transmitting station